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OCEANOGRAPHY AND THE SEA-FISHERIES[1]

AT the last Cardiff meeting of the British Association in 1891 you had as your president the eminent astronomer Sir William Huggins, who discoursed upon the then recent discoveries of the spectroscope in relation to the chemical nature, density, temperature, pressure and even the motions of the stars. From the sky to the sea is a long drop; but the sciences of both have this in common that they deal with fundamental principles and with vast numbers. Over three hundred years ago Spenser in the "Faerie Queene" compared "the seas abundant progeny" with "the starres on hy," and recent investigations show that a liter of sea-water may contain more than a hundred times as many living organisms as there are stars visible to the eye on a clear night.

During the past quarter of a century great advances have been made in the science of the sea, and the aspects and prospects of sea-fisheries research have undergone changes which encourage the hope that a combination of the work now carried on by hydrographers and biologists in most civilized countries on fundamental problems of the ocean may result in a more rational exploitation and administration of the fishing industries.

And yet even at your former Cardiff meeting thirty years ago there were at least three papers of oceanographic interest—one by Professor Osborne Reynolds on the action of waves and currents, another by Dr. H. R. Mill on seasonal variation in the temperature of lochs and estuaries, and the third by our honorary local secretary for the present meeting, Dr. Evans Hoyle, on a deep-sea-tow-net

[1] From the address of the president of the British Association for the Advancement of Science given at Cardiff on August 24, 1920.

capable of being opened and closed under water by the electric current.

It was a notable meeting in several respects, of which I shall merely mention two. In Section A, Sir Oliver Lodge gave the historic address in which he expounded the urgent need, in the interests of both science and the industries, of a national institution for the promotion of physical research on a large scale. Lodge's pregnant idea put forward at this Cardiff meeting, supported and still further elaborated by Sir Douglas Galton as President of the Association at Ipswich, has since borne notable fruit in the establishment and rapid development of the National Physical Laboratory. The other outstandng event of that meeting is that you then appointed a committee of eminent geologists and naturalists to consider a project for boring through a coral reef, and that led during following years to the successive expeditions to the atoll of Funafuti in the Central Pacific, the results of which, reported upon eventually by the Royal Society, were of great interest alike to geologists, biologists, and oceanographers.

Dr. Huggins, on taking the chair in 1891, remarked that it was over thirty years since the association had honored astronomy in the selection of its president. It might be said that the case of oceanography is harder, as the association has never had an oceanographer as president—and the association might well reply "Because until very recent years there has been no oceanographer to have." If astronomy is the oldest of the sciences, oceanography is probably the youngest. Depending as it does upon the methods and results of other sciences, it was not until our knowledge of physics, chemistry, and biology were relatively far advanced that it became possible to apply that knowledge to the investigation and explanation of the phenomena of the ocean. No one man has done more to apply such knowledge derived from various other subjects and to organize the results as a definite branch of science than the late Sir John Murray, who may therefore be regarded as the founder of modern oceanography.

It is, to me, a matter of regret that Sir John Murray was never president of the British Association. I am revealing no secret when I tell you that he might have been. On more than one occasion he was invited by the council to accept nomination and he declined for reasons that were good and commanded our respect. He felt that the necessary duties of this post would interfere with what he regarded as his primary life-work—oceanographical explorations already planned, and the last of which he actually carried out in the North Atlantic in 1912, when over seventy years of age, in the Norwegian steamer *Michael Sars* along with his friend Dr. Johan Hjort.

Any one considering the subject-matter of this new science must be struck by its wide range, overlapping as it does the borderlands of several other sciences and making use of their methods and facts in the solution of its problems. It is not only world-wide in its scope but extends beyond our globe and includes astronomical data in their relation to tidal and certain other oceanographical phenomena. No man in his work, or even thought, can attempt to cover the whole ground—although Sir John Murray, in his remarkably comprehensive "Summary" volumes of the *Challenger* Expedition and other writings, went far towards doing so. He, in his combination of physicist, chemist, geologist and biologist, was the nearest approach we have had to an all-round oceanographer. The International Research Council probably acted wisely at the recent Brussels conference in recommending the institution of two international sections in our subject, the one of physical and the other of biological oceanography—although the two overlap and are so interdependent that no investigator on the one side can afford to neglect the other.

On the present occasion I must restrict myself almost wholly to the latter division of the subject, and be content, after brief reference to the founders and pioneers of our science, to outline a few of those investigations and problems which have appeared to me to

be of fundamental importance, of economic value, or of general interest.

Although the name oceanography was only given to this branch of science by Sir John Murray in 1880, and although according to that veteran oceanographer Mr. J. Y. Buchanan, the last surviving member of the civilian staff of the *Challenger*, the science of oceanography was born at sea on February 15, 1873, when, at the first official dredging station of the expedition, to the westward of Teneriffe, at 1,525 fathoms, everything that came up in the dredge was new and led to fundamental discoveries as to the deposits forming on the floor of the ocean, still it may be claimed that the foundations of the science were laid by various explorers of the ocean at much earlier dates. Aristotle, who took all knowledge for his province, was an early oceanographer on the shores of Asia Minor. When Pytheas passed between the pillars of Hercules into the unknown Atlantic and penetrated to British seas in the fourth century B.C., and brought back reports of *Ultima Thule* and of a sea to the north thick and sluggish like a jelly-fish, he may have been recording an early planktonic observation. But passing over all such and many other early records of phenomena of the sea, we come to surer ground in claiming, as founders of oceanography, Count Marsili, an early investigator of the Mediterranean, and that truly scientific navigator Captain James Cook, who sailed to the South Pacific on a transit of Venus expedition in 1769 with Sir Joseph Banks as naturalist, and by subsequently circumnavigating the South Sea about latitude 60° finally disproved the existence of a great southern continent; and Sir James Clerk Ross, who, with Sir Joseph Hooker as naturalist, first dredged the Antarctic in 1840.

The use of the naturalist's dredge (introduced by O. F. Müller, the Dane, in 1799) for exploring the sea-bottom was brought into prominence almost simultaneously in several countries of northwest Europe—by Henri Milne-Edwards in France in 1830, Michael Sars in Norway in 1835, and our own Edward Forbes in 1832.

The last mentioned genial and many-sided genius was a notable figure in several sections of the British Association from about 1836 onwards, and may fairly be claimed as a pioneer of oceanography. In 1839 he and his friend the anatomist, John Goodsir, were dredging in the Shetland Seas, with results which Forbes made known to the meeting of the British Association at Birmingham that summer, with such good effect that a "Dredging Committee" of the association was formed to continue the good work. Valuable reports on the discoveries of that committee appear in our volumes at intervals during the subsequent twenty-five years.

It has happened over and over again in history that the British Association, by means of one of its research committees, has led the way in some important research or development of science and has shown the government or an industry what wants doing and how it can be done. We may fairly claim that the British Association has inspired and fostered that exploration of British seas which through marine biological investigations and deep-sea expeditions has led on to modern oceanography. Edward Forbes and the British Association Dredging Committee, Wyville Thomson, Carpenter, Gwyn Jeffreys, Norman and other naturalists of the pre-*Challenger* days—all these men in the quarter-century from 1840 onwards worked under research committees of the British Association, bringing their results before successive meetings; and some of our older volumes enshrine classic reports on dredging by Forbes, McAndrew, Norman, Brady, Alder, and other notable naturalists of that day. These local researchers paved the way for the *Challenger* and other national deep-sea expeditions. Here, as in other cases, it required private enterprise to precede and stimulate government action.

It is probable that Forbes and his fellow-workers on this "Dredging Committee" in their marine explorations did not fully realize that they were opening up a most comprehensive and important department of knowledge. But it is also true that in all his expeditions—

in the British seas from the Channel Islands to the Shetlands, in Norway, in the Mediterranean as far as the Ægean Sea—his broad outlook on the problems of nature was that of the modern oceanographer, and he was the spiritual ancestor of men like Sir Wyville Thomson of the *Challenger* Expedition and Sir John Murray, whose accidental death a few years ago, while still in the midst of active work, was a grievous loss to this new and rapidly advancing science of the sea.

Forbes in these marine investigations worked at border-line problems, dealing for example with the relations of geology to zoology, and the effect of the past history of the land and sea upon the distribution of plants and animals at the present day, and in these respects he was an early oceanographer. For the essence of that new subject is that it also investigates border-line problems and is based upon and makes use of all the older fundamental sciences—physics, chemistry and biology—and shows for example how variations in the great ocean currents may account for the movements and abundance of the migratory fishes, and how periodic changes in the physico-chemical characters of the sea, such as variations in the hydrogen-ion and hydroxyl-ion concentration, are correlated with the distribution at the different seasons of the all-important microscopic organisms that render our oceanic waters as prolific a source of food as the pastures of the land.

Another pioneer of the nineteenth century who, I sometimes think, has not yet received sufficient credit for his foresight and initiative, is Sir Wyville Thomson, whose name ought to go down through the ages as the leader of the scientific staff on the famous *Challenger* Deep-Sea Exploring Expedition. It is due chiefly to him and to his friend Dr. W. B. Carpenter that the British Government, through the influence of the Royal Society, was induced to place at the disposal of a committee of scientific experts first the small surveying steamer *Lightning* in 1868, and then the more efficient steamer *Porcupine* in the two succeeding years, for the purpose of exploring the deep water of the Atlantic from the Faroes in the north to Gibraltar and beyond in the south, in the course of which expeditions they got successful hauls from the then unprecedented depth of 2,435 fathoms, nearly three statute miles.

It will be remembered that Edward Forbes, from his observations in the Mediterranean (an abnormal sea in some respects), regarded depths of over 300 fathoms as an azoic zone. It was the work of Wyville Thomson and his colleagues Carpenter and Gwyn Jeffreys on these successive dredging expeditions to prove conclusively what was beginning to be suspected by naturalists, that there is no azoic zone in the sea, but that abundant life belonging to many groups of animals extends down to the greatest depths of from four to five thousand fathoms—nearly six statute miles from the surface.

These pioneering expeditions in the *Lightning* and *Porcupine*—the results of which are not even yet fully made known to science—were epoch-making, inasmuch as they not only opened up this new region to the systematic marine biologist, but gave glimpses of world-wide problems in connection with the physics, the chemistry and the biology of the sea which are only now being adequately investigated by the modern oceanographer. These results, which aroused intense interest amongst the leading scientific men of the time, were so rapidly surpassed and overshadowed by the still greater achievements of the *Challenger* and other national exploring expeditions that followed in the 'seventies and 'eighties of last century, that there is some danger of their real importance being lost sight of; but it ought never to be forgotten that they first demonstrated the abundance of life of a varied nature in depths formerly supposed to be azoic, and, moreover, that some of the new deep-sea animals obtained were related to extinct forms belonging to the Jurassic, Cretaceous and Tertiary periods.

It is interesting to recall that our association played its part in promoting the movement that led to the *Challenger* Expedition. Our general committee at the Edinburgh meeting of 1871 recommended that the president and council be authorized to cooperate with the

Royal Society in promoting "a Circumnavigation Expedition, specially fitted out to carry the Physical and Biological Exploration of the Deep Sea into all the Great Oceanic Areas"; and our council subsequently appointed a committee consisting of Dr. Carpenter, Professor Huxley and others to cooperate with the Royal Society in carrying out these objects.

It has been said that the *Challenger* Expedition will rank in history with the voyages of Vasco da Gama, Columbus, Magellan and Cook. Like these it added new regions of the globe to our knowledge, and the wide expanses thus opened up for the first time, the floors of the oceans, though less accessible, are vaster than the discoveries of any previous exploration.

Sir Wyville Thomson, although leader of the expedition, did not live to see the completed results, and Sir John Murray will be remembered in the history of science as the *Challenger* naturalist who brought to a successful issue the investigation of the enormous collections and the publication of the scientific results of that memorable voyage: these two Scots share the honor of having guided the destinies of what is still the greatest oceanographic exploration of all times.

In addition to taking his part in the general work of the expedition, Murray devoted special attention to three subjects of primary importance in the science of the sea, viz.: (1) the plankton or floating life of the oceans, (2) the deposits forming on the sea bottoms, and (3) the origin and mode of formation of coral reefs and islands. It was characteristic of his broad and synthetic outlook on nature that, in place of working at the speciography and anatomy of some group of organisms, however novel, interesting and attractive to the naturalist the deep-sea organisms might seem to be, he took up wide-reaching general problems with economic and geological as well as biological applications.

Each of the three main lines of investigation—deposits, plankton and coral reefs—which Murray undertook on board the *Challenger* has been most fruitful of results both in his own hands and those of others. His plankton work has led on to those modern planktonic researches which are closely bound up with the scientific investigation of our sea-fisheries.

His work on the deposits accumulating on the floor of the ocean resulted, after years of study in the laboratory as well as in the field, in collaboration with the Abbé Renard of the Brussels Museum, afterwards professor at Ghent, in the production of the monumental "Deep-Sea Deposits" volume, one of the *Challenger* Reports, which first revealed to the scientific world the detailed nature and distribution of the varied submarine deposits of the globe and their relation to the rocks forming the crust of the earth.

These studies led, moreover, to one of the romances of science which deeply influenced Murray's future life and work. In accumulating material from all parts of the world and all deep-sea exploring expeditions for comparison with the *Challenger* series, some ten years later, Murray found that a sample of rock from Christmas Island in the Indian Ocean, which had been sent to him by Commander (now Admiral) Aldrich, of H.M.S. *Egeria*, was composed of a valuable phosphatic material. This discovery in Murray's hands gave rise to a profitable commercial undertaking, and he was able to show that some years ago the British Treasury had already received in royalties and taxes from the island considerably more than the total cost of the *Challenger* Expedition.

That first British circumnavigating expedition on the *Challenger* was followed by other national expeditions (the American *Tuscarora* and *Albatross*, the French *Travailleur*, the German *Gauss*, *National* and *Valdivia*, the Italian *Vettor Pisani*, the Dutch *Siboga*, the Danish *Thor* and others) and by almost equally celebrated and important work by unofficial oceanographers such as Alexander Agassiz, Sir John Murray with Dr. Hjort in the *Michael Sars*, and the Prince of Monaco in his magnificent ocean-going yacht, and by much other good work by many investigators in smaller and humbler vessels. One of these supplementary expeditions I must refer to briefly because of its connection with sea-fisheries. The

Triton, under Tizard and Murray, in 1882, while exploring the cold and warm areas of the Faroe Channel separated by the Wyville-Thomson ridge, incidentally discovered the famous Dubh-Artach fishing grounds, which have been worked by British trawlers ever since.

Notwithstanding all this activity during the last forty years since oceanography became a science, much has still to be investigated in all seas in all branches of the subject. On pursuing any line of investigation one very soon comes up against a wall of the unknown or a maze of controversy. Peculiar difficulties surround the subject. The matters investigated are often remote and almost inaccessible. Unknown factors may enter into every problem. The samples required may be at the other end of a rope or a wire eight or ten miles long, and the oceanographer may have to grope for them literally in the dark and under other difficult conditions which make it uncertain whether his samples when obtained are adequate and representative, and whether they have undergone any change since leaving their natural environment. It is not surprising then that in the progress of knowledge mistakes have been made and corrected, that views have been held on what seemed good scientific grounds which later on were proved to be erroneous. For example, Edward Forbes, in his division of life in the sea into zones, on what seemed to be sufficiently good observations in the Ægean, but which we now know to be exceptional, placed the limit of life at 300 fathoms, while Wyville Thompson and his fellow-workers on the *Porcupine* and *Challenger* showed that there is no azoic zone even in the great abysses.

Or, again, take the celebrated myth of "Bathybius." In the 'sixties of last century samples of Atlantic mud, taken when surveying the bottom for the first telegraph cables and preserved in alcohol, were found when examined by Huxley, Haeckel and others to contain what seemed to be an exceedingly primitive protoplasmic organism, which was supposed on good evidence to be widely extended over the floor of the ocean. The discovery of this Bathybius was said to solve the problem of how deep-sea animals were nourished in the absence of seaweeds. Here was a widespread protoplasmic meadow up which other organisms could graze. Belief in Bathybius seemed to be confirmed and established by Wyville Thomson's results in the *Porcupine* Expedition of 1869, but was exploded by the naturalists in the *Challenger* some five years later. Buchanan in his recently published "Accounts Rendered" tells us how he and his colleague Murray were keenly on the look-out for hours at a time on all possible occasions for traces of this organism, and how they finally proved, in the spring of 1875 on the voyage between Hong-Kong and Yokohama, that the all pervading substance like coagulated mucus was an amorphous precipitate of sulphate of lime thrown down from the sea-water in the mud on the addition of a certain proportion of alcohol. He wrote to this effect from Japan to Professor Crum Brown, and it is in evidence that after receiving this letter Crum Brown interested his friends in Edinburgh by showing them how to make Bathybius in the chemical laboratory. Huxley at the Sheffield meeting of the British Association in 1879 handsomely admitted that he had been mistaken, and it is said that he characterized Bathybius as "not having fulfilled the promise of its youth." Will any of our present oceanographic beliefs share the fate of Bathybius in the future? Some may, but even if they do they may well have been useful steps in the progress of science. Although like Bathybius they may not have fulfilled the promise of their youth, yet, we may add, they will not have lived in the minds of man in vain.

Many of the phenomena we encounter in oceanographic investigations are so complex, are or may be affected by so many diverse factors, that it is difficult, if indeed possible, to be sure that we are unravelling them aright and that we see the real causes of what we observe.

Some few things we know approximately—nothing completely. We know that the greatest depths of the ocean, about six miles, are a little greater than the highest mountains on land, and Sir John Murray has calculated that

if all the land were washed down into the sea the whole globe would be covered by an ocean averaging about two miles in depth. We know the distribution of temperatures and salinities over a great part of the surface and a good deal of the botton of the oceans, and some of the more important oceanic currents have been charted and their periodic variations, such as those of the Gulf Stream, are being studied. We know a good deal about the organisms floating or swimming in the surface waters (the epi-plankton), and also those brought up by our dredges and trawls from the bottom in many parts of the world—although every expedition still makes large additions to knowledge. The region that is least known to us, both in its physical conditions and also its inhabitants, is the vast zone of intermediate waters lying between the upper few hundred fathoms and the bottom. That is the region that Alexander Agassiz from his observations with closing tow-nets on the *Blake* Expedition supposed to be destitute of life, or at least, as modified by his later observations on the *Albatross,* to be relatively destitute compared with the surface and the bottom, in opposition to the contention of Murray and other oceanographers that an abundant meso-plankton was present, and that certain groups of animals, such as the Challengerida and some kinds of Medusæ, were characteristic of these deeper zones. I believe that, as sometimes happens in scientific controversies, both sides were right up to a point, and both could support their views upon observations from particular regions of the ocean under certain circumstances.

But much still remains unknown or only imperfectly known even in matters that have long been studied and where practical applications of great value are obtained—such as the investigation and prediction of tidal phenomena. We are now told that theories require re-investigation and that published tables are not sufficiently accurate. To take another practical application of oceanographic work, the ultimate causes of variations in the abundance, in the sizes, in the movements and in the qualities of the fishes of our coastal industries are still to seek, and not withstanding volumes of investigation and a still greater volume of discussion, no man who knows anything of the matter is satisfied with our present knowledge of even the best-known and economically most important of our fishes such as the herring, the cod, the plaice and the salmon.

Take the case of our common fresh-water eel as an example of how little we know and at the same time of how much has been discovered. All the eels of our streams and lakes of N.-W. Europe live and feed and grow under our eyes without reproducing their kind—no spawning eel has ever been seen. After living for years in immaturity, at last near the end of their lives the large male and female yellow eels undergo a change in appearance and in nature. They acquire a silvery color and their eyes enlarge, and in this bridal attire they commence the long journey which ends in maturity, reproduction and death. From all the fresh waters they migrate in the autumn to the coast, from the inshore seas to the open ocean and still westward and south to the mid-Atlantic and we know not how much further—for the exact locality and manner of spawning has still to be discovered. The youngest known stages of the Leptocephalus, the larval stage of eels, have been found by the Dane, Dr. Johannes Schmidt, to the west of the Azores where the water is over 2,000 fathoms in depth. These were about one third of an inch in length and were probably not long hatched. I can not now refer to all the able investigators—Grassi, Hjort and others—who have discovered and traced the stages of growth of the Leptocephalus and its metamorphosis into the "elvers" or young eels which are carried by the North Atlantic drift back to the coasts of Europe and ascend our rivers in spring in countless myriads but no man has been more indefatigable and successful in the quest than Dr. Schmidt, who in the various expeditions of the Danish Investigation Steamer *Thor* from 1904 onwards found successively younger and younger stages, and who is during the present summer engaged in a traverse of the Atlantic to the West Indies in the hope of

finding the missing link in the chain, the actual spawning fresh-water eel in the intermediate waters somewhere above the abysses of the open ocean.

Again, take the case of an interesting oceanographic observation which, if established, may be found to explain the variations in time and amount of important fisheries. Otto Pettersson in 1910 discovered by his observations in the Gullmar Fjord the presence of periodic submarine waves of deeper salter water in the Kattegat and the fjords of the west coast of Sweden, which draw in with them from the Jutland banks vast shoals of the herrings which congregate there in autumn. The deeper layer consists of "bankwater" of salinity 32 to 34 per thousand, and as this rolls in along the bottom as a series of huge undulations it forces out the overlying fresher water, and so the herrings living in the bankwater outside are sucked into the Kattegat and neighboring fjords and give rise to important local fisheries. Pettersson connects the crests of the submarine waves with the phases of the moon. Two great waves of salter water which reached up to the surface took place in November, 1910, one near the time of full moon and the other about new moon, and the latter was at the time when the shoals of herring appeared inshore and provided a profitable fishery. The coincidence of the oceanic phenomena with the lunar phases is not, however, very exact, and doubts have been expressed as to the connection; but if established, and even if found to be due not to the moon but to prevalent winds or the influence of ocean currents, this would be a case of the migration of fishes depending upon mechanical causes, while in other cases it is known that migrations are due to spawning needs or for the purpose of feeding, as in the case of the cod and the herring in the west and north of Norway and in the Barents Sea.

William A. Herdman

University of Liverpool

JOHN SAHLBERG

John Reinhold Sahlberg passed away on the eighth of May, 1920, in Helsingfors, Finland, seventy-five years of age, having been born in Helsingfors, June, 1845.

Descriptive entomology has lost one of its prominent men; entomological societies—especially the famous Societas pro Fauna and Flora Fennica—an enthusiastic member and officer; the University of Helsingfors a learned teacher, who knew how to guide his pupils to the very source of biological knowledge—nature herself.

John Sahlberg was an unwearied and highly experienced collector, famous all over Europe, who up to his old age, undertook extensive and strenuous excursions throughout all parts of his native country. He also collected in many other countries of the old world, traveling through the northern parts of Scandinavia and Siberia, and staying in the Caucasus, Turkestan, Greece and Italy. Three times during the years 1895 and 1904 he visited Asia Minor, Palestine and Egypt. Although thoroughly familiar with all branches of entomology, it was the Cicadariæ and the Coleoptera which attracted his especial attention, and to these groups he devoted much study.

Among the many publications of John Sahlberg the following may be mentioned:

1871: Öfversigt of Finlands och den Skandinaviska halföns Cicadariæ.

1873–89: Enumeratio Coleopterorum Fenniæ.

1878–80: Bidrag till Nordvestra Sibiriens Insekt Fauna.

1900: Catalogus Coleopterorum Fenniæ Geographicus.

1912–13: Coleoptera Mediterranea Orientalia.

He has left his entomological collections, which are large and of rare systematic and faunistic value, to the Zoological Museum of Helsingfors.

John Sahlberg belonged to an old Finnish family which for generations has been connected with the learned institutions of their native land. His grandfather (Carl Reinhold S.) was professor in natural history, first at the Åbo Academy of Science, later at the University of Helsingfors. After extensive travels over all parts of the world, his father (Reinhold Ferdinand S.) was for a period teacher in zoology at the University of Helsingfors.

John Sahlberg himself was only twenty-six years old when he was appointed teacher in zoology at the University of Helsingfors. At the same institution he was professor extraordinarius in entomology from 1883 to 1918.

John Sahlberg's son is Dr. Uunio Saalas, Helsingfors (now Helsinki), an entomologist of very high standing and of international reputation.

John Sahlberg was a man of firm character and deeply interested in Christian movements and associations, especially the Y. M. C. A. and a Christian association of Finnish University students. He also was a very enthusiastic spokesman for prohibition, especially advocating it among young men. He has published and lectured on prohibition and Christian subjects.

A. G. BÖVING

SCIENTIFIC EVENTS

THE PUBLICATION OF SCIENTIFIC BOOKS IN FRANCE

THE Paris correspondent of the *Journal* of the American Medical Association writes:

The paper shortage and publishing difficulties still arouse a lively interest. M. Ducrot, in an informative article in the *Revue Scientifique* on the subject of scientific publishing in France, showed that if there was a crisis in the publication of literary works, this was particularly acute in the case of works on pure science. In fact, the elements of bookmaking have increased considerably in cost as compared to prices before the war: compositors and pressmen are paid from three to four times as much as in 1914, the price of paper is five times as great, and these factors contribute to make the cost of a book from three to four times as much as before the war. Now, the income of the intellectual classes, the only purchasers of theoretic works, has barely doubled, while the budgets of public institutions, libraries, laboratories, etc., have been greatly reduced. A book, even one that constitutes a veritable working tool, is not a prime necessity. It should not, therefore, exceed a certain price, above which it will not sell, and at the present moment, the maximum has apparently been reached.

This condition, which constitutes a veritable danger to the advance of science, is not peculiar to France. A statistical study by M. Fernand Roches in the *Correspondant* discloses the progressive decrease of the number of publications in the principal countries since 1914. Exclusive of periodicals and musical works, the figures show that a number of books published in 1918, as compared to 1917, decreased in France from 5,054 to 4,484; in Great Britain from 8,131 to 7,716; in Italy from 8,349 to 5,902; in the United States from 10,060 to 9,237, and in Germany from 14,910 to 14,743. The production in 1919 is not yet known, but it was probably less than in 1918.

It is interesting to note that the decrease in Italy totaled 2,447 books; in the United States 823; in France 570, and in England 415; but Germany, defeated and disorganized, showed a decrease of only 167 works.

So far as French medical books are concerned, statistics recently published in the *Bibliographie de la France* indicate that the number of such works, which had suffered a great decrease before the war (from 1,230 in 1910 to 721 in 1914), had again greatly declined in 1915, namely, to 202 works. A tendency to improvement was noted in 1916, and again in 1917, when 292 books appeared. However, in 1918, a new decline set in which it was believed would be accentuated in 1919, but nothing of the sort occurred and in that year 309 new books appeared.

CHEMICAL RESEARCH IN LONDON

A COMMITTEE presided over by Professor J. F. Thorpe, of the Imperial College of Science and Technology, London, has made a report recommending the creation of an All-India Chemical Service, the establishment of a central research institute at Dehra Dun, and of a similar laboratory in each province near the chief seat of industry. The broad object is to assist by scientific investigation in overcoming the difficulties and deficiencies in Indian industrial organization pointed out by the Holland Commission.

The summary in the *London Times* states that while it is the intention of Professor Thorpe and his colleagues that the research institutes should be staffed mainly by Indians, it is manifest that the universities and institutes of the country do not provide adequate training for the research work which will fall to the service. The qualifications laid down are an honor degree in the first and second class or its equivalent; a suitable training in

engineering (workshop practise and machine drawing); and one or two years training in the methods of research under a professor or teacher of a university or university institution who is competent to train in research. Sir P. C. Ray, who stands only second to Sir Jagadis Bose in eminence as an Indian scientist, in a dissentient note disapproves of the creation of yet another Indian service, and thinks the best results could be achieved by improving the teaching of chemistry in the universities. They should be encouraged to strengthen the staff of chemical teachers and to offer research scholarships. Technological institutes should be attached to each university as an adjunct to the chemical and physical departments.

The attractiveness *prima facie* to men of high scientific attainment of dependence on the universities has been shown in the last few months in the correspondence columns of *Nature*. In his introductory note to the report Dr. Thorpe, who may be presumed to have had strong leanings in the same direction when his inquiries began, is unhesitating in his conclusion that the development of chemical industries in India can only be adequately realized through the agency of an efficient Government Chemical Service. At the outset the report refers to the method, found satisfactory in England, of government subventions to research associations in the various branches of industry. But in India, with its comparatively undeveloped great natural resources, "a more intimate system of state assistance" is held to be necessary. Similarly, it is not possible at present to rely upon the Indian universities to complete the training necessary for appointment to the service, and selected students must be sent abroad under a system of maintenance agents.

It is pointed out that the formation of the service will necessitate a strengthening of the chemical departments of Indian universities and institutions. The professors of chemistry should be relieved of some of their routine work, and could then devote an appreciable amount of time to training their senior students in methods of research. The formation of a service for the purpose of industrial research does not mean that university professors should be discouraged from doing similar work. Dr. Thorpe, in his introductory note, says that while it is impossible and unnecessary to have laboratories attached to the universities fitted with full-scale apparatus, there should be attached to the chemical department in every university a laboratory of comparatively small dimensions, containing types of every kind of plant used in chemical manufacture of about one sixtieth the size of the large scale plant.

The proposed Chemical Service touches the educational service or educational institutions directly only in so far as concerns the efficient training of its recruits in research methods. For this reason it is not proposed that professors and teachers of chemistry should normally be members of the service. It would be open to the Education Department or to an educational institution to ask for a chemist to be seconded from the service if it so desires. Such chemists would retain their lien on their appointment in the Chemical Service, and could revert thereto on promotion, on their own request, or on the request of the authorities to whom their services had been lent.

NORTH AMERICAN FOREST RESEARCH

The National Research Council reports that it has published a complete summary of all of the scientific investigations upon forest problems which are now under way in the United States and in Canada as a bulletin upon "North American Forest Research." This bulletin was compiled by a committee of the Society of American Foresters composed of:

Earl H. Clapp, assistant forester, U. S. Forest Service.

Clyde Leavitt, commissioner of conservation of Canada, Ottawa.

Walter Mulford, professor of forestry, University of California.

J. W. Toumey, director of the forest school, Yale University.

E. A. Ziegler, director, State Forest Academy, Mount Alto, Penn.

In this bulletin 519 different projects for investigation are described, including the re-

forestation of cut-over areas, the replacement of timber cuttings by natural growth, the control of insect pests and fungus diseases of forest trees, beneficial modifications of lumbering practise, the preservation of timber in use, the utilization of by-products, and the relation of forestry to rainfall, control of flood waters, grazing, etc.

The importance of the most penetrating study upon the conservation of our remaining forest resources is brought home by the recent announcement of the Forest Service that "three fifths of the original timber of the United States is gone and that we are using timber four times as fast as we are growing it." Our annual consumption of lumber alone is over 300 board feet per capita, and of newsprint is 33 pounds per capita. Cut and burned over forest lands in the United States, now waste territory, equal in area the whole of the present standing forests of Denmark, Germany, Holland, Belgium, France, Switzerland, Spain and Portugal. The total population of these countries is about 152,200,000, nearly 50 per cent. greater than the population of the United States.

OFFICE OF DEVELOPMENT WORK

COMMERCIAL and industrial concerns will be helped to apply new processes and discoveries of chemists in the United States Department of Agriculture by an Office of Development Work just created by the Secretary of Agriculture in the Bureau of Chemistry. The staff of the new service will be made up of engineers rather than chemists. David J. Price, chief engineer in the dust-explosion investigations conducted by the department, will be in charge of the new work.

Dr. Carl L. Alsberg, chief of the Bureau of Chemistry, in a letter to the secretary stated that such a service is urgently needed to translate the work of the bureau into terms that could be understood and applied by the manufacturer and investor. Every year valuable discoveries are made concerning the utilization of manufacturing waste, or a new food is found, or a new dye, glue, or preservative. Without the service of a business office such as is now provided the value of these discoveries is greatly reduced through the discoverers's inability to present his proposition in terms which the business man can understand, and the public runs the risk of losing a much-needed material. Under the new organization the engineers will look after the product as soon as it has passed beyond an experimental or laboratory stage and will prepare estimates for the convenience of the manufacturers.

Mr. Price and his associates will furnish data upon raw-material supply, cost of production, and the uses to which the product is adapted—in short, they provide an unbiased practical prospectus to show the public exactly what may be expected from the new material or process on a quantity-production scale. It is believed this cooperation will develop many neglected sources of public and private profit.

SCIENTIFIC NOTES AND NEWS

PROFESSOR GEORGE M. STEWART, director of the H. K. Cushing Laboratory of Experimental Medicine of Western Reserve University, had conferred on him the degree of doctor of laws at the recent commencement exercises of the University of Edinburgh.

THE honorary fellowship of the Royal College of Surgeons of England has been conferred on Professor A. Depage, of Brussels; M. Pierre Duval, of Paris; Prof. John M. T. Finney, of The Johns Hopkins University, Baltimore, and Dr. Charles H. Mayo, of Rochester, Minnesota.

THE University of Ottawa has conferred the degree of doctor of literature on Dr. J. C. McWalter, high sheriff of Dublin, and president of the Dublin Branch of the British Medical Association.

BARON GERARD DE GEER, of Stockholm, has arrived in this country to study the geological chronology since the ice age in the United States and Canada. He is accompanied by his wife and Drs. Ernest Antevs, and Ragnar Lidén.

DR. N. L. BRITTON, director of the New York Botanical Garden, accompanied by Mrs. Brit-

ton will visit the botanical institutions of Great Britain, France and Switzerland, particularly in reference to investigations of the flora of northern South America.

Dr. Franklin L. Hunt, physicist in the aeronautic instruments section of the Bureau of Standards, who has been detailed to Paris, France, for a period of twelve months, to serve as the bureau's representative in relations with the scientific and aviation authorities of England, France, Italy, Belgium and Holland, is expected to return about the first of October.

Dr. David Marine, associate professor of experimental medicine in Western Reserve University, Cleveland, has been elected director of laboratories in the Montefiore Home and Hospital, New York City.

Mr. R. G. Upton, formerly with the Texas State Board of Health as assistant sanitary engineer, now has charge of inspection and laboratory work for the city of Port Arthur, Texas, where he is chemist and sanitary engineer.

Dr. Nicholas Kopeloff has accepted the position of associate in bacteriology at the Psychiatric Institute of the N. Y. State Hospitals, after resigning the position of bacteriologist of the Louisiana Sugar Experiment Station.

Claude Wakeland, deputy state entomologist of Colorado and in charge of alfalfa weevil investigations from 1917 to 1919, has accepted the position of state extension entomologist with headquarters at Boise.

The Robert Koch endowment at Berlin has granted Professor Flügge of Berlin 15,000 marks and Professor Selter of Königsberg 6,000 marks to aid in continuing their research on tuberculosis.

Dr. R. S. Morrell has been elected president of the British Oil and Color Chemists' Association in succession to Dr. F. Mollwo Perkin.

Major W. E. Simnett has retired from the direction and editorship of the *Technical Review* on his appointment to direct the Intelligence Branch of the British Ministry of Transport.

Dr. J. G. Lipman, director of the New Jersey Experiment Station, has been appointed consulting editor of *Annales de la Science Agronomique Française et Etrangère.*

Harvey Bassler and J. B. Mertie, Jr., on furlough from the U. S. Geological Survey, are engaged in oil geology with Eugene Stebinger in Bolivia.

Professor C. O. Sauer, of the University of Michigan, is in charge during the month of September of a summer geological camp at Mills Springs, Wayne County, Ky.

Dr. Stephen Taber, professor of geology at the University of South Carolina, has been giving courses in geology and seismology at Stanford University during the summer quarters.

The Royal College of Physicians of London has appointed lecturers as follows: Dr. F. Parkes Weber, Mitchell lecturer, 1921; Dr. G. Graham, Goulstonian lecturer, 1921; Dr. T. Lewis, Oliver Sharpey lecturer, 1921; Dr. A. Whitfield, Lumleian lecturer, 1921; Dr. R. O. Moon, FitzPatrick lecturer, 1921; and Dr. G. M. Holmes, Croonian lecturer, 1922.

In memory of Dr. John B. Murphy, of Chicago, who died in 1916, it is proposed that there be constructed at an estimated cost of five hundred thousand dollars, the John B. Murphy Memorial Hall of the American College of Surgeons on a site in Chicago given by a number of prominent citizens and accepted by the regents in behalf of the college. In this memorial the college will acquire a building architecturally beautiful and much needed for important conferences and convocations and meetings for national and local medical societies. Space will be provided also in which it is proposed to maintain a pantheon of American medicine and surgery.

John Percy, professor of mathematics at the Finsbury Technical College and later at the Royal College of Science, London, died on August 4 at the age of seventy years.

The death is announced at the age of eighty-three years of Dr. Armand Gautier, formerly professor of chemistry at the University of

Paris, president of the Academy of Sciences and of Medicine.

DR. O. SCHULTZE, professor of anatomy and physiology in the University of Wurzburg, has died at the age of sixty-one years.

WILLIAM HODGSON ELLIS, former professor of applied chemistry and dean of the faculty of applied science at the University of Toronto, died on August 24, in his seventy-fifth year.

WILLIAM JAMES WILSON, for many years paleobotanist for the Canadian Geological Survey, died at Ottawa, on August 21, aged sixty-nine years.

PROFESSOR H. D. FRARY, assistant professor of steam and gas engineering at the University of Wisconsin with his wife was drowned in August in the Wisconsin river at Kilbourn, while on a camping trip. Professor Frary had been on the university faculty during the past academic year and during the previous two years had been connected with the Forest Products laboratory. He was a graduate of the University of Minnesota and obtained the degree of doctor of philosophy at the University of Illinois in 1918.

THE sixth national exposition of chemical industries will be held in the Grand Central Palace during the week of September 20.

THE British government has provided a sum not exceeding £100,000 as a guarantee against loss resulting from the holding of a British Empire Exhibition in London next year. The grant is conditional on the provision of a further sum of £500,000 by the promoters of the enterprise.

THE Second International Congress of Comparative Pathology will be held in Rome in the spring of 1921 under the presidency of Professor Perroncito.

THE International Surgical Society at its recent general assembly, decided to hold its next international congress at London, July, 1923, under presidency of Professor Macewen of Glasgow.

IT is stated in *The Observatory* that the late Mr. T. W. Backhouse has left his astronomical journals and drawings of Jupiter and Mars to the British Astronomical Association. His trustees are to complete and publish his star maps for tracing meteor paths, and they have £700 left to them to cover the completion and publication of scientific calculations based on observations made by him in astronomy, meteorology, and other branches of science.

THE Academy of Medicine of Buenos Aires has decided to celebrate its first centenary in 1922 with a contest on medicine and allied sciences. Three prizes will be granted for the best papers presented; the first of 5,000 pesos and a gold medal, the second 3,000 pesos and a silver medal and the third 1,000 pesos and a diploma.

A SUM of 500,000 marks has been donated to the University of Heidelberg to found an institute for research on albumins. It is to be in charge of Professor Kossel, and to be affiliated with the Institute for Hygiene.

PROFESSOR J. IJIMA, of the University of Tokyo, has presented fifty Japanese birds to the University of California Museum of Vertebrate Zoology, and Dr. William S. Kew, of the United States Geological Survey, has presented to the department of paleontology a collection of shells.

A REORGANIZATION of the division of entomology at the University of California is announced. The personnel of the division consists of eight members and will hereafter be known as the division of entomology and parasitology with Professor W. B. Herms as newly appointed head. Professor Herms will continue his activities in the field of parasitology, particularly medical entomology and ecology, while Professor C. W. Woodworth will devote his time largely, if not wholly, to research. The new organization of the division embraces three groups with Assistant Professor E. C. Van Dyke as chairman in supervision of activities in general entomology and taxonomy; Assistant Professor Essig, chairman in supervision of agricultural entomology, and Assistant Professor S. B Freeborn supervising activities in parasitology, particularly in relation to the animal industries. Dr. H. H. Sev-

erin will continue investigating *Eutetix tenella* in relation to sugar beet blight, while Messrs. E. R. de Ong and G. A. Coleman will continue their activities in their respective fields, namely, university farm school and agriculture, respectively.

THE Olympia Agricultural Company, Ltd., is a British syndicate which has purchased agricultural estates aggregating 20,000 acres in the counties of Yorkshire, Northamptonshire, Cambridgeshire, Suffolk, Warwickshire and Wiltshire. The *Experiment Station Record* states that a research department has recently been organized under the direction of Dr. Charles Crowther, professor of agricultural chemistry in the University of Leeds and director of the institute for research in animal nutrition in that university. This department will exercise advisory functions in connection with the large scale farming operations of the company, and for some time its activities will consist mainly of experiments essential to the establishment of a sound basis for this advisory work, but it is announced that its primary object will be to conduct research in various branches of agricultural science and practise for the general welfare of British agriculture.

THE British Forestry Conference at the meeting held recently in London passed a resolution in favor of the formation of an Empire Forestry Association, for the promotion and development of public interest in forestry throughout the empire, and also created an interim committee to consider ways and means. The committee appointed has drawn up proposals for circulation to all parts of the empire, for the establishment of a governing council for the association, and for the formation of an interim executive committee. The committee held that in view of the vast area embraced, the association's activities, apart from occasional conferences, must take a literary form. Its principal medium of communication would probably consist of a journal, issued quarterly. A publication of this kind, dealing with the needs, problems and progress of forestry in all parts of the empire, should, it is felt, be of interest and practical value to foresters, students of forestry and owners of woodlands, as well as the architects, engineers and traders interested in the distribution and use of timber.

PLANS of the State Forestry Department for extensive reforestation in the woods and on the waste lands of Pennsylvania this year will call for the largest amount of seeds ever used and efforts are being made to secure as much as possible from indigenous trees. This will be the first time this work has been undertaken on such an extensive scale. As this is a year of heavy seed bearing by most of the species of forest trees unusually large quantities of seed will be collected from the various State forests. Any seed not planted in the four state forest tree nurseries next spring will be held over for planting the year following in case it is a lean seed year. While most of the seed to be collected will be used to grow young forest trees for planting on state lands and on private timber lands, some from deciduous trees will produce shade trees for free distribution to cities and boroughs for municipal and educational plantings.

A SECOND edition of the *Index Generalis* of universities, university colleges, libraries, scientific institutes, museums, observatories, learned societies, etc., is being prepared. Particulars are accepted from all nationalities, and should be addressed to Professor R. de Montessus de Ballore, 56, Rue de Vaugirard, Paris (VI^e).

THE birth rate for the metropolitan area of Sydney, N. S. W., for 1919 was the lowest on record, being 14 per cent. below the average for the previous five years. The rate is equivalent to 23.05 per 1,000 of population. The decline in the birth rate since 1914 has been 5 per 1,000, but probably not all the decline can be attributed to the war, as the rate, after increasing from 1903 to 1912, declined slightly from 1912 to 1914. Illegitimate children numbered 7.41 per cent. of the total births, equivalent to 1.71 per 100 of population.

IT is stated in the *Experiment Station Record* that the government of Argentina has recently offered additional scholarships in the agricultural schools of Casilda, Tucuman, Cordoba and Mendoza to young men of Peru

desiring to follow up their studies in Argentina. The municipal council of Buenos Aires, on December 22, 1919, passed an ordinance providing for the establishment of a practical school of aviculture in connection with the zoological garden. During the apprentice period pupils will be required to give their services to the school gratuitously. On the completion of the course a diploma as practical aviculturist will be given. In the Colombian Ministry of Agriculture a department of cattle and meat inspection has been established to study contagious cattle diseases and their remedies, and to inspect cattle and meat products intended for export to countries which demand certificates of inspection. A law of November 5, 1919, grants a subsidy of about $10,000 for the establishment of a course in agriculture and industries in the University of Nariño. The Department of Agriculture of Cuba has decided to establish a bureau of commercial information in European and American countries for the purpose of establishing cordial commercial relations between Cuba and the other countries. The first bureau will be established in France.

UNIVERSITY AND EDUCATIONAL NEWS

At a meeting of Messrs. Brunner, Mond, and Co., at Liverpool, on August 4, a resolution to authorize the directors to distribute to universities or other scientific institutions in the United Kingdom for the furtherance of scientific education and research, $500,000 out of the investment surplus reserve account was passed.

The University of Tennessee College of Medicine will erect a pathologic laboratory building to cost $75,000 near the Memphis General Hospital. This is in accordance with a contract between the university and the Memphis General Hospital by which the school has entire control of the teaching facilities in the hospital for a period of twenty years and the school will nominate the medical, surgical and laboratory staffs of the hospital.

Dr. Gilbert H. Cady, who has been connected with the Geological Survey of Illinois for several years and who has recently returned from a year spent in mining interests in the far east, has accepted the position of professor of geology and head of the department in the University of Arkansas. He also becomes state geologist of Arkansas.

At Northwestern University Miss Margaret Fuller, M.A., Chicago, has been appointed instructor in geology and Mr. Thomas Lloyd Gledhill, M.A., Toronto, has been appointed instructor in mineralogy and geology.

F. A. Varrelman, acting professor of botany at Occidental College, Los Angeles, during 1919–20 has accepted a professorship at the State Normal School, Silver City, New Mexico. Dr. F. A. Smiley will reassume the work in this department at Occidental College, having been at the University of California during the past year.

O. A. Haugen, formerly instructor at the University of Wisconsin is returning this fall as assistant professor of chemical engineering. He is at present connected with the Carborundrum company at Niagara Falls.

Dr. English Bagby has been appointed instructor in psychology at Yale University.

Dr. W. N. Haworth has been appointed to the chair of organic chemistry at Armstrong College, Newcastle-upon-Tyne, in succession to Professor S. Smiles.

DISCUSSION AND CORRESPONDENCE

THE OBLIGATION OF THE INVESTIGATOR TO THE LIBRARY

The dependence of the present-day investigator upon institutional libraries is almost absolute. Necessarily so, as only a very exceptional person can own, or provide room for, a library complete enough to cover the range of his professional interests. Even if he owned the books he could not care for them and do anything else. Except in his own special field, no investigator will attempt to compete with the skilled bibliographers of our better libraries, and even in his own field he is apt to appear at a disadvantage. One

of the most careful workers of my acquaintance recently located, after much search, the title of a somewhat obscure work on stomata, only to find, shortly after, that the book was plainly catalogued under the heading STOMATA in the library of the institution in which he was at work.

The work of the librarian is important to the investigator not only in making the results of previous researches available now, but in the attempt to insure present results being available in the future. If the results of the investigations of to-day are anywhere available to succeeding generations it will be in the larger libraries where the publications containing them are being carefully collected and catalogued. We have heard much recently about cooperation among investigators, its desirability, its difficulty, and its disadvantages, and the means by which its undesirable features may be avoided and its disadvantages and difficulties lessened. Might not brief consideration well be given to cooperation between the investigator and the most important of his co-laborers, a cooperation which can have neither difficulties nor disadvantages?

Those of us who are much in the field, perhaps, appreciate more keenly than those who are always in touch with their homes the special advantages of the public library. In these days of closed bars and crowded hotels the one place where the stranger is sure of a welcome is the public library. And, speaking seriously, the importance and influence in small communities of libraries as well stocked and well conducted as those of Poughkeepsie, New York, and Riverside, California, for example is hard to estimate. Now that Mr. Carnegie has provided these institutions all over the country with suitable buildings, in his commendable effort to die poor, why should not the investigator, who must die poor anyway, look to their contents?

The smaller public libraries need help especially in this particular. The almost overwhelming demand on these libraries for fiction, especially recent fiction, should not be permitted to exclude scientific material from their shelves. If the results of our labors, or the methods, or even the activities themselves, are to be made known to the reading public, as much of our literature as possible must be made available in public libraries. Every public library should have at least SCIENCE and the *Scientific Monthly*. If you find a library that lacks them, urge the authorities to subscribe, and if they lack the funds, give them your own set.

The investigator has, moreover, an obligation to the college library, the library of the college from which he graduated perhaps, or the one nearest his home. Other alumni will care for other interests, the pious for the erection of a new chapel, the more worldly minded for the gymnasium, but the library is too often left to shift for itself, and provided with insufficient funds. This applies particularly to the smaller colleges of course, but it is indeed a rare university library to which the average investigator can not add some volume in the course of ten years' work, and that volume will on the whole be much more useful and safer in a good library than in a private study or laboratory.

From the standpoint of self-interest as well as of common honesty, however, the first duty of the investigator is to the reference libraries, whether general libraries like the John Crerar Library and those of our leading universities, or libraries covering special fields such as the Lloyd Library or those connected with our large botanic gardens. If an investigator accepts the hospitality and uses the facilities of the Library of the Marine Biological Laboratory at Woods Hole, or that of Stanford University, and one is made quite at home in both without introduction, it seems no more than fair that these libraries be supplied in return with as complete a set as possible of his own publications if they lie within the field of interest of the library. I am reliably informed that this practise is by no means general. Comparatively few of the investigators of my acquaintance take the trouble to send reprints of their publications even to the Library of Congress.

That these papers are usually published in

standard periodicals, of which complete sets are supposedly available in these libraries does not cover the case. The United States at least is afflicted with several scientific periodicals of avowedly general nature, and some of the special journals have a none too stable editorial policy. Some of these special journals moreover still further complicate bibliographical work by permitting the publication of abstracts of work which at some time may be judged worthy of adequate publication, thus cluttering their indices beyond the point of convenience if not utility.

If then our libraries, even our special libraries, are to approximate completeness in their indices of current published scientific material they should have the assistance of the investigators themselves, at least to the extent of supplying them with such articles as are reprinted for private circulation. It is an almost universal custom for investigators to distribute reprints of their own papers among their colleagues. To add to these private mailing lists the names of the fifty leading libraries of this and other countries would mean some trouble and some slight expense. The time and cost thus involved would however be a very small fraction indeed of that expended in the prosecution and publication of the work and the insurance thus purchased that the papers would be cared for and made more available to this and succeeding generations would be well worth the investment.

NEIL E. STEVENS
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

THE FUR SEALS

TO THE EDITOR OF SCIENCE: In an interesting and suggestive article on the "Rescued Fur Seal Industry" in SCIENCE for July 23, Mr. W. T. Hornaday states that "man's so-called management (of the herd) lies solely in the use of the seal killer's club and the skinning knife." This is not quite the whole truth, for while the behavior of individual animals in feeding, breeding, or migration is beyond human control, man can do something to increase the numbers. In the nineties, most of the young seals lying on sandy "rookeries" were killed by the hookworm (*Uncinaria lucasi*). Those on the rocks were virtually immune and as the shrinkage of the herd, before its rescue took them practically all off the sands, no "wormy pups" are lately reported. In 1897, the Commission of that year gather up—and mostly burned—12,000 "pups" that had been weakened by the hookworm and then trampled by the bulls. In that year we had several sandy patches in Zapadni rookery covered by rocks, and we suggested fencing the animals away from the great sand flat of Tolstoi. To cover or fence up sandy areas is a possible factor of "management."

Another is the extirpation of the "idle bulls" which surround the rookeries and raid the harems, killing many females and young. Ninety per cent. or more of the males of this polygamous species are wholly superfluous. In the recent absurdly needless "five years closed season" these have accumulated to the danger point. I am told that an order has now been given for the shooting of 7,000 of them.

The protection of the females from killing on land and sea may be also regarded as a phase of "management."

Whether other islands could be stocked from the Pribilofs has never been tested. On these islands there is ample breeding space for millions more, and there is no evidence of food shortage outside.

DAVID STARR JORDAN

A PRELIMINARY NOTE ON THE GERMINATION OF UROPHLYCTIS ALFALFÆ

RESTING spores from decaying galls of alfalfa crown-wart have been observed to germinate in water cultures. The globose resting spores, depressed on one side, are 38–42 by 30 microns in diameter. They produce from one to fifteen or more zoosporangia which escape through irregular fissures in the brown walls. The zoosporangia vary in diameter from 10 to 40 microns. Zoospores leave the sporangia through short tubes projecting about 2 microns from the hyaline wall, with

an opening of about 2 microns in diameter. There are usually four or five tubes in large sporangia and one tube in small sporangia.

The zoospores are somewhat ovoid in form, 4 to 8 microns in length and very flexible. The single cilium, 30 to 50 microns in length, is attached at the broader posterior end and trails behind when the spore is actively swimming. There is usually one bright eyespot, but there may be two. Conjugation of zoospores has not been seen in my cultures.

Within twelve hours after leaving the sporangia most of the zoospores settle down at the margin of the hanging drop and become rounded in form. A single germ tube develops and grows out from the edge of the drop and along the surface of the cover glass. If the spore has come to rest too far from the margin, the mycelium grows downward and projects from the drop of water. The tube may reach a length of 10 to 20 microns in 24 hours after the zoospore has left the sporangium. The mycelium usually branches freely and irregularly after it reaches a length of about 10 microns. In cultures 9 days old the mycelium averaged about 20 microns in length. It varied from 10 to 60 microns (total length of branches).

Old galls are likely to contain nematodes, Paramœcium and other ciliate protozoa, several kinds of flagellates and amoeboid protozoa. Some of these feed on the zoospores, as many as 30 having been counted in a single Paramœcium. Cultures free from these organisms were obtained by transferring ripe sporangia, by means of a mechanically operated micropipette, into hanging drops of water. The zoospores escaped from the sporangia and sent out germ tubes in these cultures.

Much difficulty was encountered in finding galls with spores that would germinate. Even in such galls, only a very small percentage of the resting spores germinated. In some cases the zoospores escaped when the hyaline wall was extruded only slightly through the fissure in the brown wall. Usually the sporangium became entirely free before the spores were released.

Hanging drop cultures of spores from several galls produced sporangia for about two weeks. Attempts to hasten the release of zoospores by keeping these cultures on ice over night were not successful. Cultures containing sporangia were allowed to become partially dry for a few minutes and then moistened again. This effected the escape of zoospores from ripe sporangia. It did not change sporangia appreciably in which the contents had not become differentiated into spores.

Germination was obtained in November (1906) and in March, April, May, June and July (1920).

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SCIENTIFIC BOOKS

Hand-List of Scientific Manuscripts in the British Isles dating from before the Sixteenth Century. By Dorothea Waley Singer. London, De La More Press, 1919. 8o. 12 pp.

Survey of Medical Manuscripts in the British Isles dating from before the Sixteenth Century. By Dorothea Waley Singer. London, J. Bale, Sons & Danielsson, Ltd., 1920, 8o, 12 pp.

These are important contributions to the early history of medieval medicine and science, the first fruits of a catalogue of some 30,000 scientific manuscripts of the Middle Ages, found in Britain, and now in preparation by Dr. Singer and his wife. The value of such a catalogue to future students will be incalculable, going forward as it does simultaneously with the cataloguing and intensive study of the scientific and medical incunabula. As the social and scientific history of modern medicine is to be found largely in the files of medical periodicals of the eighteenth to the twentieth centuries, so the unwritten history of medieval science is contained in the manuscripts, the pathway to which lies through the early printed books.

Until very recent years, the history of medieval science has been regarded with mingled feelings, whether of indifference or aversion, due to the fact that real knowledge of the subject, as based upon the elliptical data in the printed literature, is so meager as to be deceptive, while what little is known has been constantly misread, over-stated or misinterpreted, according to the religious bias of the expositors. Until Sudhoff began to photograph and interpret the hitherto undiscovered medical manuscripts on the continent of Europe, such valuable source-books of medieval folk-medicine as Oswald Cockayne's "Leechdoms, Wortcunning and Starcraft of Early England" (1864–6) remained undisturbed on the dustier shelves of libraries. But with the foundation of the Leipzig Institute (1905), things began to take a new turn. The classified hand-list of manuscripts which Dr. and Mrs. Singer are making is an important move in aid of the problem: "How are we to trace the disintegration of Greek science in the Middle Ages and the slow processes which led to the apparently sudden rise of the experimental method?" Before we can investigate the great mass of undigested manuscript material, we must first have a reasoned catalogue; while to catalogue all the manuscripts in a single country is the first step to a classified "world catalogue" of such manuscripts. Encouraged by grants from the Royal Society and the British Academy, the Singer catalogue has already progressed far enough to enable its compilers to block out their classification by subjects. This list of subjects, replete with such rubrics as Aristotle, Menology, Bestiaries, Magic, Cosmology, Herbaria, Lapidaries, Marvels, Melothesia Physiognomy, Cheiromancy, etc., already affords a glimpse into the medieval mind; and could we conceive of a medieval scientific library, public or private, as attaining to any great size (impossible by reason of the costliness of the illuminated manuscripts and printed incunabula), we should have an inkling of the probable arrangement of its books, by alcoves and shelves. Some 15,000 of these manuscripts are medical, and, of these, 1,900 are on general medicine, 953 alchemical, 600 magical, 194 surgical, 178 gynecological, 72 pediatric, 144 veterinary, 274 on pulse-lore, 274 on uroscopy, 234 on blood-letting, 144 on diet, 18 on fevers, 90 on the pest, 63 on the eye, 600 on herbs and simples, 114 on physiognomy and cheiromancy, 106 on generation, while no less than 669 are bestiaries and 2,500 collections of recipes. These figures at once give a better notion of the extent to which medicine was followed in the Middle Ages, than any existing lists of medical incunabula. Most of these manuscripts were written between 1200 and 1500 A.D., and but few before the eighth century. Mrs. Singer shows by curve-tracing their distribution in time, the curve taking an abrupt and constantly upward slope after the thirteenth century. The second paper (1920) concludes with a highly instructive set of 34 legends for lantern slides of specimen pages.

F. H. GARRISON

ARMY MEDICAL MUSEUM

SPECIAL ARTICLES

THE ARRANGEMENT OF ATOMS IN SOME COMMON METALS

DURING the past year the crystal structures of several elementary substances have been determined. A brief summary of the results will be given here. Complete data will be published in the *Physical Review*.

The method is the same as that previously used.[1] A narrow beam of monochromatic X-rays is passed through the powdered material to be analyzed and produces on a photographic plate a pattern of fine lines. These lines are due to the reflection of the X-rays from the faces of the tiny crystals, one line for each kind of face. From the positions and intensities of the lines the crystal structure can be calculated.

CALCIUM

Calcium has generally been considered hexagonal, partly from analogy with magnesium

[1] *Phys. Rev.*, 10, 661, 1917; *Proc. A. I. E. E.*, 38, 1171, 1919. See also Debye & Sherrer, *Phys. Z.*, 18, 291, 483, 1917.

and zinc, and partly from a statement of Moissan[2] that it grows in hexagonal plates and rhombohedra.

The X-ray analysis shows it to be a perfect *face-centered cubic* arrangement of atoms, the side of the elementary cube being 5.56 Å. Each Ca atom is surrounded by 12 equidistant nearest neighbors, at distances of 3.93 Å.

TITANIUM

There is no crystallographic data regarding titanium. The X-ray analysis shows it to be a *centered cubic* arrangement, like chromium and iron. The side of the elementary cube is 3.144 Å. Each atom is surrounded by eight others, at distances of 2.72 Å.

ZINC

The arrangement of atoms in zinc is like that in magnesium, namely: *hexagonal close packed* (one of the two alternative arrangements that solid spheres assume when packed as closely as possible) except that it is elongated 14 per cent. in the direction of the hexagonal axis. The arrangement is that of *solid prolate spheroids in closest possible packing.*

Each atom is surrounded by six nearest neighbors, in its own plane, at distances of 2.67 Å, and by six others, three above and three below, at distances of 2.92 Å.

The observed axial ratio, 1.86, bears no simple relation to the value 1.356 found by crystallographers. The data on which the latter is based are, however, very unsatisfactory.

CADMIUM

The structure of cadmium is like that of zinc, namely: a *close packed arrangement of prolate spheroids.* The elongation of the spheroids is slightly greater than for zinc, viz., 16 per cent., corresponding to an axial ratio (ratio of altitude to side of elementary hexagonal prism) of 1.89.

Each atom has six nearest neighbors in its own plane at distances of 2.98 Å., and six others almost as near, three above and three below, at distances of 3.30 Å.

[2] See Groth, Chemische Krystallographie.

As in the case of zinc the observed axial ratio, 1.89, bears no obvious relation to the crystallographer's value, 1.335.

INDIUM

The atoms of indium are arranged in a *face-centered tetragonal lattice.* The axial ratio, that is, the ratio of altitude to base of the elementary tetragonal prism, is 1.06. The lattice is therefore like "cubic close packing" except that it is elongated 6 per cent. in the direction of one of the cubic axes. *It is a close-packed arrangement for prolate spheroids,* alternative with the zinc and cadmium type.

The side of the elementary prism is 4.58 Å., and its height 4.86 Å. Each indium atom has four nearest neighbors at distances of 3.24 Å., and eight others, four above and four below, at distances of 3.33 Å.

The crystallographic data assigned indium to the cubic system.

RUTHENIUM

The arrangement of atoms in ruthenium, like that in zinc and cadmium, is very close to *hexagonal close packing.* In this case, however, the lattice is *shortened* in the direction of the hexagonal axis by 3 per cent., giving an axial ratio of 1.59. *This is a close-packed arrangement for oblate spheroids.*

Each ruthenium atom is surrounded by six, in its own plane, at distance of 2,686Å., and by six others, three above and three below, at distances of 2.640 Å.

PALLADIUM

The atoms of palladium are in *face-centered cubic* arrangement. This is the "cubic close packed" arrangement for perfect spheres.

The side of the elementary cube is 3.92 Å. Each atom is surrounded by twelve equidistant neighbors at distances of 2.77 Å.

TANTALUM

The atoms of tantalum are in *centered cubic* arrangement, like tungsten. The side of the elementary cube is 3.272 Å. Each atom is surrounded by eight nearest neighbors at distances of 2.83 Å.

IRIDIUM

The atoms of iridium, like platinum, are in *face-centered cubic* arrangement.

The side of the elementary cube is 3.80 Å., and the distance from one atom to each of its twelve nearest neighbors 2.69 Å.

ALBERT W. HULL
SCHENECTADY

EFFECTS PRODUCED BY X-RAY ENERGY ACTING UPON FROGS' OVA IN EARLY DEVELOPMENTAL STAGES

SEVERAL interesting and possibly significant facts were ascertained, in connection with the general study of the action of X-ray energy upon the fertilized frogs' ovum, through raying the entire egg at different developmental stages up to the time of closure of the neural tube. Because of the chemical and physical ontogenetic processes involving both proanlagen constituents, enzyme and nutritive, and immediately anticipating the morphologic features of differentiation, it was supposed that these substances must show a variable degree of absorption of energy dependent upon the stage of development. When the quantity of energy utilized remained constant, the defects produced should vary with the stage rayed. One might anticipate both gross and microscopic morphologic variations in the developed embryos. The results of this experiment, however, are precisely of the reverse nature.

The eggs were permitted to develop in the ponds where they were laid until the proper stage of development had been reached, whereupon they were brought immediately into the laboratory and rayed. Development was permitted to progress in glass jars of a capacity of 1,000 c.c., the water being changed frequently. Of the 300 eggs used for the experiment, upwards of fifty were sectioned serially. The embryos were fixed in formalin after Schultze's method at varying intervals after raying. None, however, was permitted to develop to the time of metamorphosis. In all of the experiments the distance from the target to the eggs and the per-second energy output of the tube were constant as was also the time of exposure. The tube carried a current strength of 50 milliamperes at 50 K.V. A dosage of 100 mam. was given to each group of from twenty to twenty-five eggs. These were placed 17.5 cm. from the target. The different groups represented approximately every developmental stage from the two-cell to the period of the closure of the neural tube. No attempt was made to orient the eggs with reference to the tube so that the animal pole or the vegetable pole or right side or left side of the embryos should be uppermost.

Contrary to what one might at first anticipate, the developed embryos were identical in every gross and microscopic detail to those produced by raying the whole ovum at the two-cell stage as described by the author in the *Anatomical Record* of November, 1919. This uniformity of results, irrespective of the stage rayed, is the most striking feature of the experiment. Sections of these embryos resemble in every histological detail those produced by the former method, and could serve very well to illustrate the results of that investigation. Since the author has already given these details, it would be superfluous to duplicate that description in this paper. The experiment represents, therefore, still another method by means of which a standardized, defective, morphologic condition may be produced.

Owing chiefly to our present lack of knowledge of the association of chemical formula with morphologic structure in the ovum, a completely satisfactory explanation of this phenomenon can not be given. Before such may be attempted, prolonged experimentation along this line must necessarily be carried out. This represents merely one step in the experimental analysis of the ovum and whatever conclusions are drawn from the phenomenon produced must be based very largely upon hypothesis.

The factors concerned fall into two natural categories, one embryological and the other chemical or physical, *i. e.*, one dealing with the embryological mechanism affected, and the other with the nature of the change produced in the physical and chemical constitution of the ovum. Granting the presence of a series of chemical ontogenetic modifications preceding

the known morphologic features of cell differentiation, it is not impossible that one and the same molecule whether falling in the category of proanlagen nutritive or enzymatic substance might, regardless of the oxidative or reductive changes incident to its elaboration, show the same capacity of absorption of energy in the two-cell stage as in the gastrula no neural-plate stages. A constant and uniform alteration of this molecule might be assumed to lead to a correspondingly constant and uniform embryological result. To the mind of the author, however, this assumption appears less probable than the hypothesis that certain protoplasmic substances maintain a constant structure, both physical and chemical, during the early stages of ontogeny. It argues equally well for the results produced whether we determine the nature of this constant content to be nutritive or enzyme, since it is conceivable that the deprivation of the enzymes of the substances out of which the morphological structures of differentiation are formed would lead to the same developmental result as the inhibitive effect of energy acting upon the ferments themselves. The presence of retardation effects is well attested both by this and by the earlier experiment and might well be accounted for on these grounds.

It is significant that in these specimens there is an absence of evidence pointing towards the destruction either of protoplasmic or of nuclear material. A more severe degree of injury brought about by the use of a greater amount of energy was evident through the presence of both protoplasmic and nuclear detritus. Furthermore, it must be pointed out that the change brought about is not incompatible with the vitality of the cells. There appears to have been suspended apparently the function of but one physiological factor of cell development, that of differentiation, unattended by any morphologic indication of destruction. The precise nature and location of this alteration, if morphologic, can not at present be identified.

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THE AMERICAN CHEMICAL SOCIETY. V

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

H. D. Batchelor, *chairman*

H. E. Howe, *secretary*

The symposium on cellulose chemistry attracted considerable attention and it was voted to hold a second symposium at the time of the autumn meeting in Chicago. The purpose of these symposia is to determine whether the formation of a section of Cellulose Chemistry within the society is feasible, some seventy-five members having expressed themselves in favor of such a project in discussing the matter by correspondence. The question of specifications for reagent chemicals and the standardization of laboratory apparatus and instruments brought out a number of valuable contributions, both from manufacturers and consumers, indicating willingness on the part of all concerned to cooperate in bringing about the standardization which is recognized as necessary. The subject of stimulating research in pure and applied chemistry and devising an incentive to such research gave rise to a lengthy discussion in which the economic status of the chemist was brought in. The present situation with reference to professors and instructors was discussed at length, involving the conditions for research in the various institutions and what might be done toward improving circumstances. The result of Dr. Comey's investigation would seem to indicate that at present the chemist is being as well paid for his services on the average as are the members of any of the other professions and that those in responsible positions in industry have shown a remarkable advance in earning power during the last few years. At the September meeting a symposium on the conservation and utilization of fuel will be held in addition to the symposium on cellulose chemistry and general papers.

Mechanism of the reactions of cellulose: Jessie E. Minor. The charge upon the cellulose is the result of the selective adsorption of the ions of an electrolyte by means of the residual valence which certain atoms or groups of atoms upon the surface of the colloid are capable of exerting. The subsequent swelling of a colloid in the presence of acids and bases is due to the absorption of water by the colloid as a result of a dialyzing or a repulsive force associated with the presence of the electrolyte ion. The hydration of cellulose is due

to the swelling of the colloidal cellulose which has received an electrolytic charge from the hydroxyl ions in the water in which it is immersed. The hydrolysis is the direct result of the presence of the electrolyte ions whose primary effect had been hydration. The formation of oxycellulose is probably preceded by the hydrolysis of the cellulose whereby the CO group is rendered more attackable for the oxygen. The solution by zinc chloride is due to the peptization of the cellulose by the adsorbed ions with the formation of a viscous emulsion. The union between cellulose and dye is due primarily to adsorption.

The determination of cellulose in woods: S. A. MAHOOD. A uniform size of particle appears to be essential if comparable results are to be obtained in the determination of cellulose in woods. Material which passes an 80-mesh standard sieve but is retained on a 100-mesh sieve has been found to be most satisfactory from the standpoint of both yield and manipulation. Material obtained by a single mechanical process of disintegration may give a sample on sifting which is not representative. To avoid this a combination of two processes, sawing and grinding, has been used. The apparatus recommended by Sieber and Walter for use in chlorination appears to give a lower yield of cellulose than the original Cross and Bevan method probably because of the temperature at which chlorination takes place.

Nitrocellulose from wood pulp: R. G. WOODBRIDGE, JR. Due to shortage of cotton, Germany was obliged early in the world war to use wood cellulose in place of cotton for making smokeless powder. Up to about July, 1918, it was not anticipated that any wood cellulose would be required in the U. S. in spite of the enormous production of smokeless powder proposed for the balance of 1918 and for the year 1919. However, the shortage in the cotton crop, due to the drought in the summer of 1918, would have made it necessary to have supplemented the short-fibered cotton by wood pulp had the war continued. This emergency had been foreseen and experiments had been in progress for several years on the question of nitrating wood cellulose for smokeless powder manufacture. These experiments showed that a mixture of cotton and wood pulp containing up to 50 per cent. of the latter could be nitrated, purified and made into smokeless powder without any important change in equipment, with no serious loss in production, and with no change in the quality of the smokeless powder.

Notes on the manufacture of nitrocellulose: J. O. SMALL and C. A. HIGGIN. In selecting a cellulose to be used for nitrating, attention should be given to both its chemical and physical properties. The biological character of the crude fiber and its purification are the chief factors influencing the chemical properties of a cellulose, while the physical properties comprise cleanliness, color and type of fiber. From the chemical analysis of a cellulose much may be learned concerning previous treatments and its subsequent behavior when nitrated. The most important tests are (1) solubility in sodium or potassium hydroxide, (2) furfural content, (3) ether-extractive matter. Nitrocellulose for explosives must pass rigid stability tests. Purification treatments of long duration are often necessary. Since the cotton fiber is hollow, pulping is necessary to remove the last traces of acid, while alcohol dehydration improves stability by the solution of the lower nitrated, unstable types. In the non-explosive arts the most common effects of instability are the formation of a brittle film, discoloration of dyes and corrosion in metal lacquers. By the use of alkaline treatments following an acid hydrolysis, better stability may be obtained without impairing the appearance of the nitrocellulose solution.

Certain aspects of the chemistry of cellulose acetate from the colloidal viewpoint: G. J. ESSELEN. Considering cellulose as a colloidal aggregate, certain of the changes involved in the preparation and use of cellulose acetate are considered from the colloidal viewpoint. With these considerations as a basis, a theory is offered to explain a number of previously unconnected facts regarding the solubility of cellulose acetate.

Projects of the preliminary committee on American cotton research: H. E. HOWE.

Is it advisable to form a section of cellulose chemistry? JASPER E. CRANE.

The determination of cellulose in woods: L. F. HAWLEY. A uniform size of particle appears to be essential if comparable results are to be obtained in the determination of cellulose in woods. Material which passes an 80-mesh standard sieve but is retained on a 100-mesh sieve has been found to be most satisfactory from the standpoint of both yield and manipulation. Material obtained by a single mechanical process of disintegration may give a sample on sifting which is not representative. To avoid this a combination of two processes, sawing and grinding, has been used. The apparatus recommended by Sieber and Walter

for use in chlorination appears to give a lower yield of cellulose than the original Cross and Bevan method probably because of the temperature at which chlorination takes place.

Cellulose phthalate; its preparation and properties: H. A. Levey.

The effect of impurities on the metallurgy of tungsten: Clarence W. Botka. A study was made of the effect of such oxides as those of iron, cobalt, calcium, sodium, aluminum, magnesium, thorium and the rare earths on the density of ignited tungsten oxide and of the tungsten metal powder resulting from its reduction in hydrogen. Further observation was made of the effect of these impurities upon the grain size of sintered tungsten ingots. In general it may be said that iron and cobalt render the metal exceedingly hard and difficult to work, and produce an exaggerated grain growth. Such impurities as the oxides of calcium, aluminum, magnesium, etc., tend to block grain growth during sintering and in some instances make it necessary to prolong this operation.

The separation and examination of the isomers of xylene: W. D. Turner and K. K. Kershner. Samples of xylene, obtained through the kindness of the Laclede Gas Light Co. were submitted to a series of fractional sulphonations and crystallizations of various sulphonic salts, according to a scheme suggested by the research department of the Eastman Kodak Co. The processes were first carried out in glassware after which the resulting modifications were tried in small size industrial apparatus. The process as applied consisted essentially of four successive sulphonations, the oil remaining unaffected holding the para-xylene. This was sulphonated with fuming sulphuric acid and converted to the barium salt for recrystallization after which it yielded pure para-xylene by hydrolysis. The ortho- and meta-sulphonic acids were converted to the sodium salts which were separated by fractional crystallization. Subsequent hydrolysis yielded pure ortho- and meta-xylenes.

The preparation of furfural from corn cobs: H. L. Dunlap and V. K. Fischlowitz. Varying concentrations of sulfuric acid, from 5.8 normal to 1 normal, were used to treat the material in a thirty-five gallon enameled steam jacketed kettle. Three normal sulfuric acid was found to be best. Concentrations beyond this decomposes some of the furfural thus cutting down the yield. When rapid steam distillation was used, the time for refluxing is about two hours. The more rapid the steam distillation the better, as the furfural will be carried over in larger quantities for the distillate collected. If the distillation is too long drawn out, poorer yields will result owing to decomposition. The liquid in the kettle must not be allowed to concentrate too rapidly in the beginning of the distillation. Sulfuric acid does not serve as well as hydrochloric acid for the condensation of the pentoses, but it permits of the use of condensers other than of glass. Benzene can be used as a solvent in place of the more expensive and more highly volatile ether.

The carbonization of Missouri cannel coals: H. L. Dunlap and K. K. Kerschner. Five different cannel coals were subjected to destructive distillation in a gas-fired horizontal retort and the results compared with a bituminous coal coked under the same conditions. Both the oils and gases collected at different stages of the carbonization were examined. Different cannel coals show a wide variation in the yield of distillation products. The decomposition temperature for cannel coals is much lower than that of bituminous coals. The oils from cannel coals have a low specific gravity and consist chiefly of paraffin hydrocarbons. These oils resemble the oils obtained by low-temperature carbonization of bituminous coals. Cannel coals yield a larger quantity of gas than bituminous coals and this gas has a high calorific and illuminating value. Again, this is what is found in the coking bituminous coals at a low temperature. With the removal of the sulfur compounds, cannel coal gas would be a valuable illuminating gas. Cannel coals yield little ammonia due to the low temperature of carbonization. Only two of the coals examined gave a coke of any commercial value. Again, these coals would not be a source for benzene and toluene unless coked at a higher temperature than used in these tests.

(*To be continued*)

Charles L. Parsons,
Secretary

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